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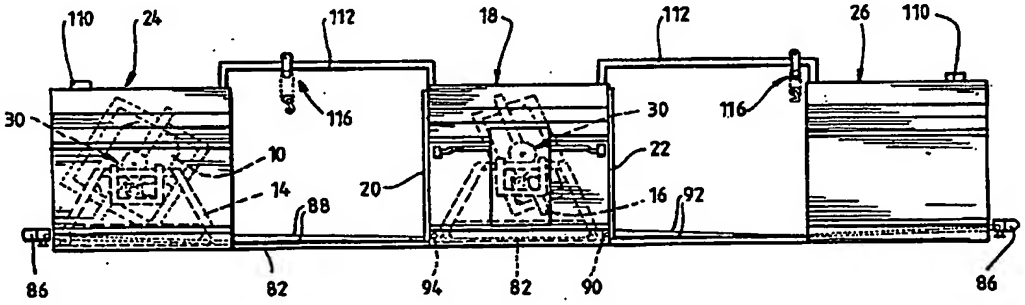

(57) Abstract

A shuttle rotamoulding apparatus which comprises first and second rotatable moulds (10, 12) mounted for biaxial rotation on first and second trolleys (14, 16) respectively. An oven (18) large enough for one of the trolleys (14, 16) to be wheeled therein is provided for heating the mould in order to rotamould the product within the mould. The oven (18) is provided with first and second doorways (20, 22) located on opposite sides of the oven (18) through which the first and second trolleys (14, 16) can pass respectively. The apparatus also comprises first and second cooling bays (24, 26) for cooling the first and second moulds (10, 12) on their respective trolleys (14, 16) respectively. The first and second trolleys (14, 16) operate substantially independently of each other, and each trolley is provided with its own mould drive assembly (30) including an electric motor (32) for rotating the mould, mounted on a motor mounting frame (48). The oven (18) is provided with an opening (50) extending along one side wall (52) through which the motor mounting frame (48) can protrude when the trolley enters the oven (18). The shuttle rotamoulding apparatus and method is particularly advantageous for rotamoulding large products, and facilitates substantially continuous operation of the oven (18) without inefficient down time.

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SHUTTLE ROTAMOULDING APPARATUS AND METHOD

FIELD OF THE INVENTION

The present invention relates to a shuttle rotamoulding apparatus and method and relates particularly, though not exclusively, to such an apparatus and method for rotamoulding large products.

BACKGROUND TO THE INVENTION

Rotational moulding (or rotamoulding) is a process for manufacturing hollow plastic products in which a powdered thermoplastic material, typically polyethylene and/or polypropylene, is melted in a heated mould and in which there is typically no pressure applied to cause the plastics material to take up the shape of the mould. Plastics powder is placed in one half of a mould which is then closed and rotated in an oven. Typically the mould itself is rotated biaxially about two perpendicular axes, although in some rotamoulding systems the mould is rotated about one axis inside an oven, and the oven itself and/or the mould is pivoted about a second perpendicular axis (the so-called "rock and roll" rotamoulding system).

As the mould rotates in the oven it heats up, typically to around 200°C, and the plastics material powder starts to melt and coat the inner surface of the mould. Due to the biaxial movement of the mould the powder distributes itself substantially uniformly over the entire inner surface of the mould. When all the powder is melted, the mould is cooled to cause the melted plastics material to solidify in the desired shape. Rotation of the mould is then ceased and it can then be opened to remove the plastic product. The advantages of rotamoulding are increasingly being recognised by manufacturers, particularly the relatively low cost of moulds, the production of stress-free products (always a problem with injection moulding) and the possibility of novel shapes and designs.

One popular form of prior art rotamoulding

apparatus is the so called "carousel" rotamoulding system which typically comprises at least three moulds mounted at the outer extremities of a corresponding number of arms. Each arm extends radially from a central rotary drive which can rotate the arms like a carousel or rotary clothes hoist. There are typically three stations located about the central drive angularly spaced at 120° intervals. The first station is a loading station where the rotamoulded product is removed and a new shot of plastics powder placed in the mould. The second station is an oven within which the mould is heated and rotated to effect the rotamoulding, and the third station is a cooling chamber where the mould is cooled prior to removal of the product at the first station. The speed at which the arms can be rotated through each station is largely dependent on the "cooking" time of the product in the mould. Each arm is provided with a pair of frames at its outer extremity for rotating the mould biaxially in the first and second stations.

The carousel type rotamoulding system can operate very efficiently as it facilitates rapid movement of the moulds to and from each station, and also enables substantially continuous use of the oven. However, one of the disadvantages of the carousel system is that it occupies a relatively large factory floor space in order to accommodate the rotation of the arms. A further disadvantage is the limitation on the size of product that can be moulded. This limitation stems from the mechanical strength of the arm which must be able to support the weight of the mould and product at its outer extremity, and also of the drive transmission which must be able to supply the power to biaxially rotate the frames over the radial length of the arms from a drive typically located at the centre of rotation of the arms. For products requiring a mould having a diameter of rotation larger than approximately 1.5m the "rock and roll" rotamoulding system is currently the only alternative available.

SUMMARY OF THE INVENTION

The present invention was developed with a view to providing a shuttle rotamoulding apparatus and method that is capable of handling larger products than the carousel system but is still relatively efficient to operate.

According to one aspect of the present invention there is provided a shuttle rotamoulding apparatus comprising:

first and second rotatable moulds mounted for bi-axial rotation on first and second trolleys respectively;

an oven for receiving one of said trolley-mounted rotatable moulds therein and adapted to heat the mould during rotamoulding of a product within the mould, said oven having at least a first doorway through which said first and second trolleys can pass whereby, in use, as soon as one of said first and second trolleys is removed from the oven it can be replaced by the other trolley so that the oven is kept in substantially continuous use.

Advantageously each trolley operates substantially independently of the other trolley and is provided with its own mould drive assembly including a motor for rotating the mould. Preferably each trolley comprises: a wheel base having a plurality of wheels and a support frame mounted thereon; a first rotatable frame rotatably mounted on the support frame and adapted to rotate the mould about a first axis; and, a second rotatable frame rotatably mounted on the first rotatable frame and adapted to rotate the mould about a second axis. Preferably said apparatus further comprises rails adapted to receive said trolley wheels thereon and arranged to guide the first and second trolleys into and out of the oven.

In one embodiment said oven is provided with first and second doors located on opposite sides of the oven, and said rails pass under the doors and emerge from both sides of the oven. Preferably the apparatus further comprises first and second cooling bays for cooling said first and second moulds on their respective trolleys respectively. In a

preferred embodiment of the apparatus said cooling bays and oven are arranged in a linear array with said first and second cooling bays located on opposite sides of the oven respectively.

Advantageously the motor of said mould drive assembly of each trolley is mounted substantially to one side of the trolley on a motor mounting frame so as to be spaced apart in a horizontal direction from said wheel base, and said oven is provided with an opening along one side through which said motor mounting frame can protrude when the trolley enters the oven whereby, in use, the rotatable mould can be rotated in the oven without the motor being heated in the oven at the same time.

Typically, said mould drive assembly also includes a chain and sprocket drive transmission, including a first drive shaft rotatably mounted on said first axis and mechanically coupled to said first rotatable frame, said first drive shaft extending from said one side of the trolley to said motor mounting frame.

According to another aspect of the present invention there is provided a shuttle rotamoulding method, the method comprising the steps of:

loading a first mould mounted on a first trolley for bi-axial rotation;

moving said first trolley into an oven in order to heat the first mould, and rotating the first mould biaxially within the oven during heating;

loading a second mould mounted on a second trolley for bi-axial rotation;

moving said first trolley out of the oven after sufficient heating, and moving the second trolley into the oven in order to heat the second mould, and rotating the second mould biaxially within the oven during heating, so that the oven is kept in substantially continuous use.

Preferably the method further comprises cooling the first mould after it is moved out of the oven; removing the rotamoulded product from within the first mould and reloading

the first mould so as to be ready for the next heating cycle; moving the second trolley out of the oven after sufficient heating and moving the first trolley back into the oven for again heating and rotating the first mould, cooling the second mould after it is moved out of the oven, and so on.

In a preferred embodiment of the method, said first trolley is moved into and out of the oven from one side of the oven and said second trolley is moved into and out of the oven from the other side of the oven.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to facilitate a better understanding of the nature of the invention, a preferred embodiment of the shuttle rotamoulding apparatus and method will now be described in detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a side elevation schematic illustrating the general layout of one embodiment of the shuttle rotamoulding apparatus;

Figure 2 is a perspective view of a first cooling bay used in the shuttle rotamoulding apparatus of Figure 1;

Figure 3 is a perspective view of an oven used in the shuttle rotamoulding apparatus of Figure 1;

Figure 4 is a perspective view of a second cooling bay used in the shuttle rotamoulding apparatus of Figure 1;

Figure 5 is an end view of a trolley used in the shuttle rotamoulding apparatus of Figure 1;

Figure 6 is a side elevation of the trolley shown in Figure 5; and,

Figure 7 is a plan view of the trolley shown in Figure 5.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

A preferred embodiment of the shuttle rotamoulding apparatus according to the invention as illustrated in Figures 1 to 4 comprises first and second rotatable moulds 10, 12 mounted for biaxial rotation on first and second

trolleys 14, 16 respectively. An oven 18 large enough for one of the trolleys 14, 16 to be wheeled therein is provided for heating the mould in order to rotamould the product within the mould. In the illustrated embodiment the oven 18 is provided with first and second doorways 20, 22 located on opposite sides of the oven 18 through which the first and second trolleys 14, 16 can pass respectively. The shuttle apparatus of this embodiment also comprises first and second cooling bays 24, 26 for cooling the first and second moulds 10, 12 on their respective trolleys 14, 16 respectively. In this particular embodiment the oven 18 and the first and second cooling bays 24, 26 are arranged in a linear array, with the first and second cooling bays located on opposite sides of the oven facing the doorways 20, 22 respectively. In Figure 1 the first trolley 14 is shown located in the first cooling bay 24, whilst the second trolley 16 is located in the oven 18. First and second doors are provided on the oven 18 for closing the first and second doorways 20, 22 respectively whilst the oven is operating. In Figure 1 the doors are shown closed while the oven is heating the second mould 12.

The first and second trolleys 14, 16 operate substantially independently of each other, and each trolley is provided with its own mould drive assembly 30 including an electric motor 32 for rotating the mould as illustrated in Figures 5 to 7. Each trolley 14, 16 comprises a wheel base 34 in the form of a rectangular-shaped steel frame having four wheels 36 and a support frame 38 mounted thereon. As can be seen most clearly in Figure 7, each trolley further comprises a first rotatable rectangular frame 40 rotatably mounted on the support frame 38 and adapted to rotate the mould 10 about a first axis 42. A second rotatable rectangular frame 44 is rotatably mounted on the first rotatable frame 40 and is adapted to rotate the mould 10 about a second axis 46 which is substantially perpendicular to the first axis 42.

As can be seen most clearly in Figures 5 and 7, the

motor 32 of the mould drive assembly 30 is mounted substantially to one side of the trolley on a motor mounting frame 48 so as to spaced apart a distance A in a horizontal direction from the wheel base 34. As illustrated in Figure 3, the oven 18 is provided with an opening 50 extending along one side wall 52 through which the motor mounting frame 48 can protrude when the trolley enters the oven 18. Hence, the rotatable mould 10, 12 can be rotated in the oven without the electric motor 32 being heated within the oven at the same time. In this way, a standard electric motor 32 can be employed requiring no special heat insulation or protection from the high temperatures experienced within the oven 18 during rotamoulding. Each trolley is provided with a panel 54 (see Figure 6) sized to be received in the opening 50 in the side wall 52 of the oven when the trolley is wheeled into the oven. Panel 54 is heat insulated and is designed to prevent the escape of heat and heated air from within the oven 18 through the opening 50. Hinged panels 51 are provided (Figure 3) on side wall 52 to close the gaps in opening 50 on both sides of panel 54 when the trolley is wheeled into the oven. Alternatively, panel 54 may be in the form of an elongate boom of a length corresponding to the full length of opening 50.

The first rotatable frame 40 is mounted on the support frame 38 of the trolley on bearings 56. A drive shaft 58 passes through the bearing 56 on one side of the trolley and extends across the distance A to the motor mounting frame 48 where it is rotatably mounted on a second bearing 56. Drive shaft 58 is fixed to the first rotatable frame 40 and has mounted thereon first and second double sprockets 60, 62. The first double sprocket is located immediately adjacent the rotatable frame 40 between the frame 40 and the support frame 38, whereas the second double sprocket 62 is mounted adjacent the outer extremity of the drive shaft 58 above the motor 32. A double sprocket chain 64 couples the second sprocket 62 to the motor 32 via a third double sprocket 66 connected to the output shaft of the motor

gearbox 68. Electric motor 32 is fitted with a brake so that whenever the power to the motor is cut off, the brake is applied to the output shaft of the gearbox 68, and via the chain 64 to the drive shaft 58 of the first rotatable frame 40. As can be seen in Figure 6, an idler sprocket 69 is rotatably mounted on a cross-bar of the motor mounting frame 48 and can be used to tension the chain 64. The position of idler sprocket 69 can be adjusted to alter the tension on chain 64.

In order to drive the second rotatable frame 44 about the second axis 46, the mould drive assembly further comprises a splined transmission shaft 70 mounted on and parallel to one side of the first rotatable frame 40 by means of bearings 72. At one end the transmission shaft 70 is provided with a fourth double sprocket 74 which is mechanically coupled to the first double sprocket 60 by means of a double sprocket chain 76. The other end of the transmission shaft 70 is provided with a bevel gear 78 that meshes with a second bevel gear 80 fitted to a drive shaft of the second rotatable frame 44. It will be seen therefore that as the first rotatable frame 40 is driven via the chain 64 and double sprocket 62 on the drive shaft 58, the second rotatable frame 44 is simultaneously driven by the transmission shaft 70, the fourth double sprocket 74 and chain 76, and the bevel gears 78, 80. The gear ratios of the bevel gears 78, 80 and the sprockets 60, 74 are preferably selected so that the second rotatable frame 44 rotates at approximately the same speed as the first rotatable frame 40. In this way, the mould 10 may be rotated bi-axially on the trolley 14 at any time.

As shown in Figure 7, splined transmission shaft 70 is provided in two sections which are normally coupled together to form a single shaft 70 by a sleeve 71. Sleeve 71 is formed with internal splines that mesh with the external splines on shaft 70 so that the full torque developed at sprocket 74 is transmitted to bevel gear 78. The purpose of providing sleeve 71 is to allow an operator to disengage the

drive transmission from the second rotatable frame 44, so that the second rotatable frame 44 can rotate independently of the first rotatable frame 40. This is particularly advantageous during unloading of the mould 10 mounted in the second rotatable frame 44, and the placing of a new shot of powder into the mould. It is much easier to remove the product from the mould if the two rotatable frames 40, 44 are brought to a position in which they both lie in the same plane. However, because the rotation of the two frames is normally locked together this may take up to 20 rotations. The provision of sleeve 71 means that it is only necessary to rotate the first rotatable frame 40 to the desired position, which may require only half a rotation. The sleeve 71 is then slid to one side to disengage the second rotatable frame 44 which can then be rotated manually to bring it into alignment with the first frame 40. A locking pin or latch (not shown) may be provided for temporarily holding the second frame 44 in a fixed position relative to the first frame 40 during unloading. When a fresh shot of powder has been placed in the mould the sleeve 71 can be returned to the engaged position.

The preferred embodiment of the rotamoulding apparatus also includes a pair of rails 82 adapted to receive the trolley wheels 36 thereon and arranged to guide the first and second trolleys 14, 16 into and out of the oven 18. The rails 82 extend substantially the full length of the apparatus as shown in Figure 1, so that theoretically one of the trolleys could be rolled from one of the cooling bays through the oven and into the opposite cooling bay. However, in practice this would rarely occur and the first trolley 14 would only move from the first cooling bay 24 into the oven 18 and back again following rotamoulding, and the second trolley 16 would only move from the second cooling bay 26 into the oven 18 and back again to the second cooling bay 26, so that the movement of the trolleys 14, 16 follows a shuttle pattern in the apparatus.

In order to effect the shuttle movement of the

trolleys 14, 16, each trolley is provided with a trolley chain drive actuated by respective first and second electric motors 84, 86 provided at ground level behind the first and second cooling bays 24, 26 respectively. A first chain 88 driven by the first motor 84 has one end connected to one side of the wheel base 34 of the first trolley 14 and the other end is connected to the opposite side of the wheel base 34 of the first trolley 14. The first chain 88 extends all the way from the first motor 84 through the oven 18 to a centrally-located floor-mounted sprocket 90. The second trolley 16 is likewise provided with a chain 92 having its ends connected to the respective sides of the wheel base 34 of the second trolley and extending from a sprocket provided on the second electric motor 86 to a centrally-located floor-mounted sprocket 94 provided on the opposite side of the oven 18 (see Figure 3). Hence, by driving electric motor 94 in one direction the chain 88 will pull the first trolley 14 out of the first cooling bay 24 into the oven 18, and by reversing the direction of motor 84 the chain 88 will pull the first trolley 14 out of the oven 18 and back into the cooling bay 24. The electric motor 86 and chain 92 operate in a similar manner to move the second trolley 16 in and out of the oven 18 and the second cooling bay 26.

Figures 2 and 4 illustrate the first and second cooling bays 24, 26 respectively. Each cooling bay is open at the front and has two sidewalls 96, 98, a roof 100, a rear wall 102 and a floor 103. The sidewall 98, on the same side of the apparatus as the sidewall 52 of the oven 18, is provided with an elongate opening 104 similar to the opening 50 in the sidewall 52 of the oven. Opening 104 extends the length of the cooling bay and is designed to receive the panel 54 of the trolley when the trolley is rolled into the cooling bay. A canopy 106 extends from the sidewall 98 above the opening 104 outwards a sufficient distance to accommodate the motor mounting frame 48 of the trolley, and then extends downwards to ground level where supporting braces 108 connect to the structural frame of the cooling bay. Canopy 106

performs a dual function. On the one hand, it provides a protective cover for the electric motor 32 and other exposed parts of the mould drive assembly 30. This helps to ensure both the mechanical integrity of the mould drive system as well as operator safety. Secondly, the canopy 106 also provides support for the upper section of the sidewall 98 which is otherwise structurally unsupported due to the gap formed by opening 104.

Typically, each cooling bay is provided with a plurality of water spray jets mounted just below the roof 100 (not illustrated) and adapted to provide a fine spray or mist of cooling water to assist in cooling of the mould 10 within the cooling bay. An exhaust fan 110 is provided in the roof 100 of the cooling bay to exhaust hot air and water vapour from within the cooling bay. Advantageously, a gantry 112 extends from the roof 100 of the respective cooling bays 24, 26 to the roof 114 of the central oven 18. Each gantry 112 is fitted with a block and tackle pulley system 116 which may be used for unloading the mould 10 of each trolley, particularly where the rotamoulded product is a heavy and/or large article which is not easily handled manually. Stops 118 may be provided adjacent the ends of the rails 82 within the cooling bays (see Figure 4) to prevent the further travel of the trolley once it has been fully drawn into its respective cooling bay.

The structural frame for each cooling bay is typically manufactured from rectangular steel tubing welded together in modules and clad with sheet metal. The rails 82 are formed by two lengths of angle iron bolted back-to-back. Hence, the floor 103 of the cooling bay forms a single module formed with two lengths of angle iron along each longitudinal edge. Sidewall 98 with canopy 106 and braces 108 form another module which has a second length of angle iron welded to the inner ends of the braces 108. When the cooling bay is reconstructed, these two modules bolt together by means of the two lengths of angle iron which form a section of one of the rails 82. The other sidewall 96, roof 100 and rear wall

102 each form separate modules which can be rapidly demounted and packed into containers for shipping, and quickly reassembled at the destination site. All of the interior surfaces of the cooling bay are coated with an epoxy paint sealer to provide protection against corrosion and the floor 103 is fitted with drain holes to prevent the accumulation of cooling water within the cooling bay. Most of the cooling water from the spray mister is drawn out of the cooling bay by the exhaust fan 110.

The central oven 18 is of similar construction, however in this case both the sidewalls 52, 118, the doors at each end for covering the doorways 20, 22, and the roof 114 are clad with sheet metal on both the inside and the outside with the space between filled with a suitable insulating material, for example, a fibreglass insulating wool. Preferably, the roof 114 is of double thickness to minimise heat loss through the roof of the oven 18. As shown in Figure 3, the doors at each end of the oven 18 are shown in the closed position. Each door is hinged to the sidewall 118, and in this embodiment must be opened and closed manually in order to move the respective trolley into and out of the oven on rails 82. A thermostatically-controlled, fan-forced gas heater 120 pumps hot air into the interior of the oven 18 in order to raise the temperature within the oven to the levels required for rotamoulding of products within the mould 10 rotatably mounted on the respective trolleys. If required, an exhaust fan 122 may also be provided for allowing the air pumped into the interior of the oven 18 to exhaust to atmosphere.

Like the cooling bays 14, 16, the oven 18 is also provided with its own canopy 124 extending outwards from the sidewall 52 from above the opening 50. Canopy 124 performs a similar function to the canopy 106 of the cooling bays.

In the illustrated embodiment, a control panel 126 for the shuttle rotamoulding apparatus is mounted on the outside of the canopy 124 of the oven 18. Control panel 126 may include a programmable logic controller (PLC) and/or

microprocessor-based control system for controlling the operation of the electric motors 32 of the mould drive assemblies on the trolleys 14, 16, the operation of the thermostatically-controlled, fan-forced gas heater 120 and the electric motors 84, 86 for controlling movement of the trolleys 14, 16 between their respective cooling bays and the central oven. Preferably, a remote control unit 128 connected to the control panel 126 is provided at each end of the canopy 124 so that an operator can control the movement of the respective trolleys into and out of the oven 18 whilst keeping the trolley in full sight at all times. If desired, a mechanical door opener and closer may be fitted to the respective oven doors to facilitate the automatic opening and closing of the doors when required. Control panel 126 typically also includes a visual readout of important operational characteristics of the apparatus such as, for example, the temperature inside the oven 18. Both a visual and audible alarm may be provided for indicating when a programmable "cooking time" for the rotamoulded product has expired indicating that the trolley currently within the oven 18 must be removed and replaced with the other trolley.

A preferred method for rotamoulding a product using the shuttle apparatus illustrated will now be described with reference to Figure 1. After the mould 10 mounted on the first trolley 14 has cooled sufficiently to allow the rotamoulded product to be removed from the mould, rotation of the first and second rotatable frames 40, 44 is ceased, and the trolley may be moved out of the cooling bay 24 into the space between the cooling bay and the oven 18. Using the gantry 112 and the block and tackle 116 the rotamoulded product is removed from the mould 10 and a new shot of plastics material powder is placed in the mould before it is closed. Typically, the mould 10 is provided with quick-release levers to facilitate rapid opening and closing of the mould 10.

The trolley 14 is then moved back into the cooling bay 24 so that the door on doorway 20 of the oven 18 can be

opened at the required time. Meanwhile, the second mould 12 is being heated and biaxially rotated on the second trolley 16 within the oven 18. Once the product within the second mould 12 has been "cooked" sufficiently, the gas heater 120 is temporarily turned off and the door on doorway 22 is opened and the motor 86 activated to pull the second trolley 16 out of the oven 18 into the cooling bay 26. For safety reasons, it may be desirable to deactivate the electric motor 32 of the mould drive assembly 30 whilst the trolley 16 is being moved into the cooling bay. However, once it reaches the cooling bay the motor 32 is reactivated and the mould 12 continues to rotate whilst being cooled within the cooling bay. The mister/spray system within the cooling bay 26 and exhaust fan 110 are activated in order to commence cooling the mould 12. Typically, the mister/spray system and exhaust fan 110 also operate on a timer switch controlled by the control panel 126.

Meanwhile, the door covering the doorway 22 of the oven 18 is immediately closed once the trolley 16 has been pulled out of the oven, and the other door 20 is opened to allow the first trolley 14 to be moved into the oven. It is preferred that only one of the oven doors be open at any one time in order to minimise the heat loss from the oven interior. However, if desired, both doors could be opened simultaneously and movement of the first and second trolleys 14, 16 synchronised so that as one trolley moves out of the oven into its cooling bay the other trolley simultaneously moves out of its cooling bay and into the oven. As soon as the first trolley 14 is inside the oven 18 the door covering doorway 20 of the oven is closed and the gas heater 120 reactivated to heat the mould 10 to the required rotamoulding temperature. At the same time, the mould drive assembly of the first trolley 14 is activated to commence biaxial rotation of the mould 10 within the oven.

Once the mould 12 in the second cooling bay 26 has cooled sufficiently, the trolley can be moved, (if necessary), into the space between the oven and the cooling

bay for removal of the product within the mould 12 using the overhead gantry 112 and block and tackle pulley system 116. Once the finished product is removed, a fresh shot of plastics powder is placed in the mould 12, which is then sealed ready for returning to the oven 18 when the product in the first mould 10 has finished "cooking". The above shuttle process can be repeated indefinitely to keep the oven 18 operating substantially continuously 24 hours a day, 7 days a week if necessary.

Although the trolleys 14, 16 of the described shuttle rotamoulding apparatus are particularly suited to the rotamoulding of large hollow products, such as water storage tanks, they may also be used to rotamould smaller products, by mounting several identical or different moulds with similar cooking times within the second rotatable frame 44 of the trolley. In this way, the shuttle rotamoulding apparatus and method can be used to rotamould both large and small products.

Now that a preferred embodiment of the shuttle rotamoulding apparatus and method have been described in detail, numerous variations and modifications will suggest themselves to persons skilled in the rotamoulding arts, in addition to those already described, without departing from the basic inventive concepts. For example, although in the described embodiment the cooling bays and oven are arranged in a linear array with the oven 18 located between the first and second cooling bays, this is by no means the only possible configuration of the apparatus. For example, both cooling bays could be located on substantially the same side of the oven 18, which in this case need only be provided with a single door for allowing both trolleys to be moved both in and out of the oven. Curved rails leading out of the oven and into the respective cooling bays would allow the trolleys to be moved in and out of the oven in substantially the same manner as that described above. The determining factor as to the preferred arrangement of the cooling bays and the oven will usually be the available factory floor space. Also, the

cooling bays may be provided with a rear door to allow either one of the first and second trolleys to be temporarily removed and replaced with another trolley having a different mould mounted thereon. In this way, the rotamoulding apparatus can be quickly changed over to a different product line, without having to shut down the oven 18 whilst new moulds are fitted to the first and second trolleys. All such variations and modifications are to be considered within the scope of the present invention, the nature of which is to be determined from the foregoing description.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A shuttle rotamoulding apparatus comprising:

first and second rotatable moulds mounted for bi-axial rotation on first and second trolleys respectively;

an oven for receiving one of said trolley-mounted rotatable moulds therein and adapted to heat the mould during rotamoulding of a product within the mould, said oven having at least a first doorway through which said first and second trolleys can pass whereby, in use, as soon as one of said first and second trolleys is removed from the oven it can be replaced by the other trolley so that the oven is kept in substantially continuous use.

2. A shuttle rotamoulding apparatus as defined in claim 1, wherein each trolley operates substantially independently of the other trolley and is provided with its own mould drive assembly including a motor for rotating the mould.

3. A shuttle rotamoulding apparatus as defined in claim 2, wherein each trolley comprises:

a wheel base having a plurality of wheels and a support frame mounted thereon;

a first rotatable frame rotatably mounted on the support frame and adapted to rotate the mould about a first axis; and,

a second rotatable frame rotatably mounted on the first rotatable frame and adapted to rotate the mould about a second axis.

4. A shuttle rotamoulding apparatus as defined in claim 3, wherein said apparatus further comprises rails adapted to receive said trolley wheels thereon and arranged to guide the first and second trolleys into and out of the oven.

5. A shuttle rotamoulding apparatus as defined in claim 4, wherein said oven is provided with first and second doors located on opposite sides of the oven, and said rails pass under the doors and emerge from both sides of the oven.

6. A shuttle rotamoulding apparatus as defined in claim 1, further comprising first and second cooling bays for cooling said first and second moulds on their respective trolleys respectively.

7. A shuttle rotamoulding apparatus as defined in claim 6, wherein said cooling bays and oven are arranged in a linear array with said first and second cooling bays located on opposite sides of the oven respectively.

8. A shuttle rotamoulding apparatus as defined in claim 3, wherein the motor of said mould drive assembly of each trolley is mounted substantially to one side of the trolley on a motor mounting frame so as to be spaced apart in a horizontal direction from said wheel base, and said oven is provided with an opening along one side through which said motor mounting frame can protrude when the trolley enters the oven whereby, in use, the rotatable mould can be rotated in the oven without the motor being heated in the oven at the same time.

9. A shuttle rotamoulding apparatus as defined in claim 8, wherein each trolley is provided with a heat insulated panel mounted on said one side of the trolley adjacent said motor mounting frame and sized to be received in said opening in the side of the oven to prevent the escape of heat from within the oven through the opening in use.

10. A shuttle rotamoulding apparatus as defined in claim 3, wherein said mould drive assembly also includes a chain and sprocket drive transmission, including a first drive shaft rotatably mounted on said first axis and

mechanically coupled to said first rotatable frame, said first drive shaft extending from said one side of the trolley to said motor mounting frame.

11. A shuttle rotamoulding method, the method comprising the steps of:

loading a first mould mounted on a first trolley for bi-axial rotation;

moving said first trolley into an oven in order to heat the first mould, and rotating the first mould biaxially within the oven during heating;

loading a second mould mounted on a second trolley for bi-axial rotation;

moving said first trolley out of the oven after sufficient heating, and moving the second trolley into the oven in order to heat the second mould, and rotating the second mould biaxially within the oven during heating, so that the oven is kept in substantially continuous use.

12. A shuttle rotamoulding method as defined in claim 11, further comprising cooling the first mould after it is moved out of the oven; removing the rotamoulded product from within the first mould and reloading the first mould so as to be ready for the next heating cycle; moving the second trolley out of the oven after sufficient heating and moving the first trolley back into the oven for again heating and rotating the first mould, cooling the second mould after it is moved out of the oven, and so on.

13. A shuttle rotamoulding method as defined in claim 12, wherein said first trolley is moved into and out of the oven from one side of the oven and said second trolley is moved into and out of the oven from the other side of the oven.

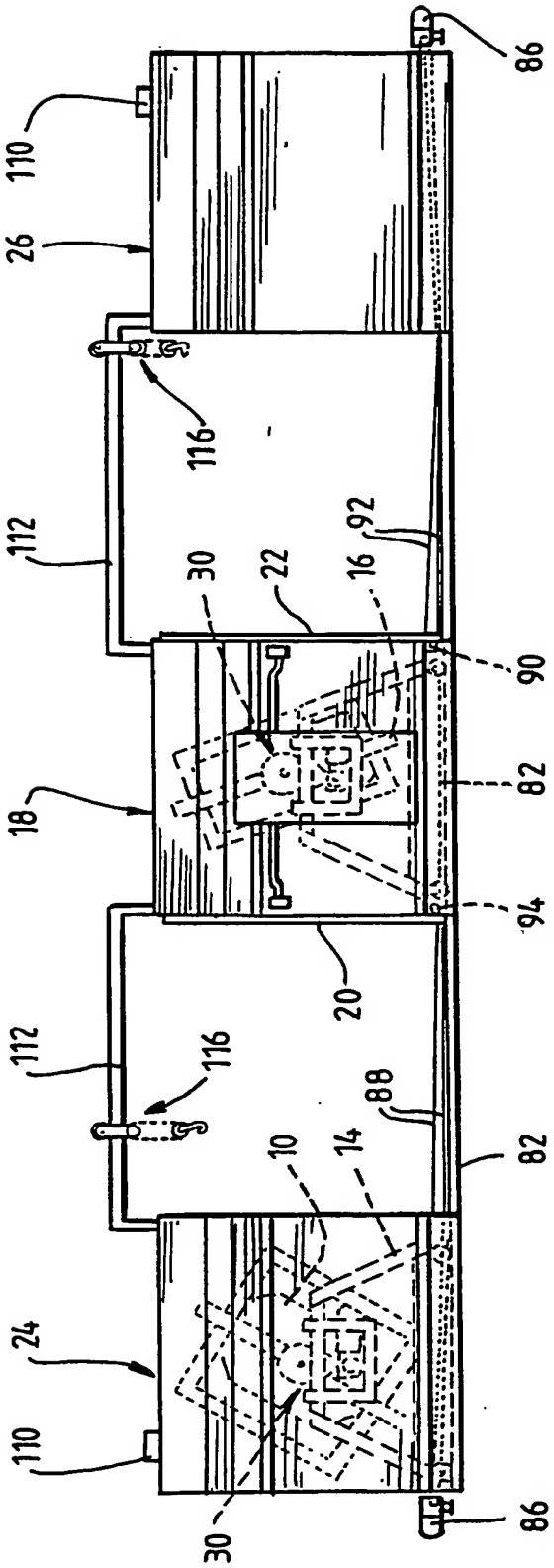
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FIG. 1.

FIG. 2.

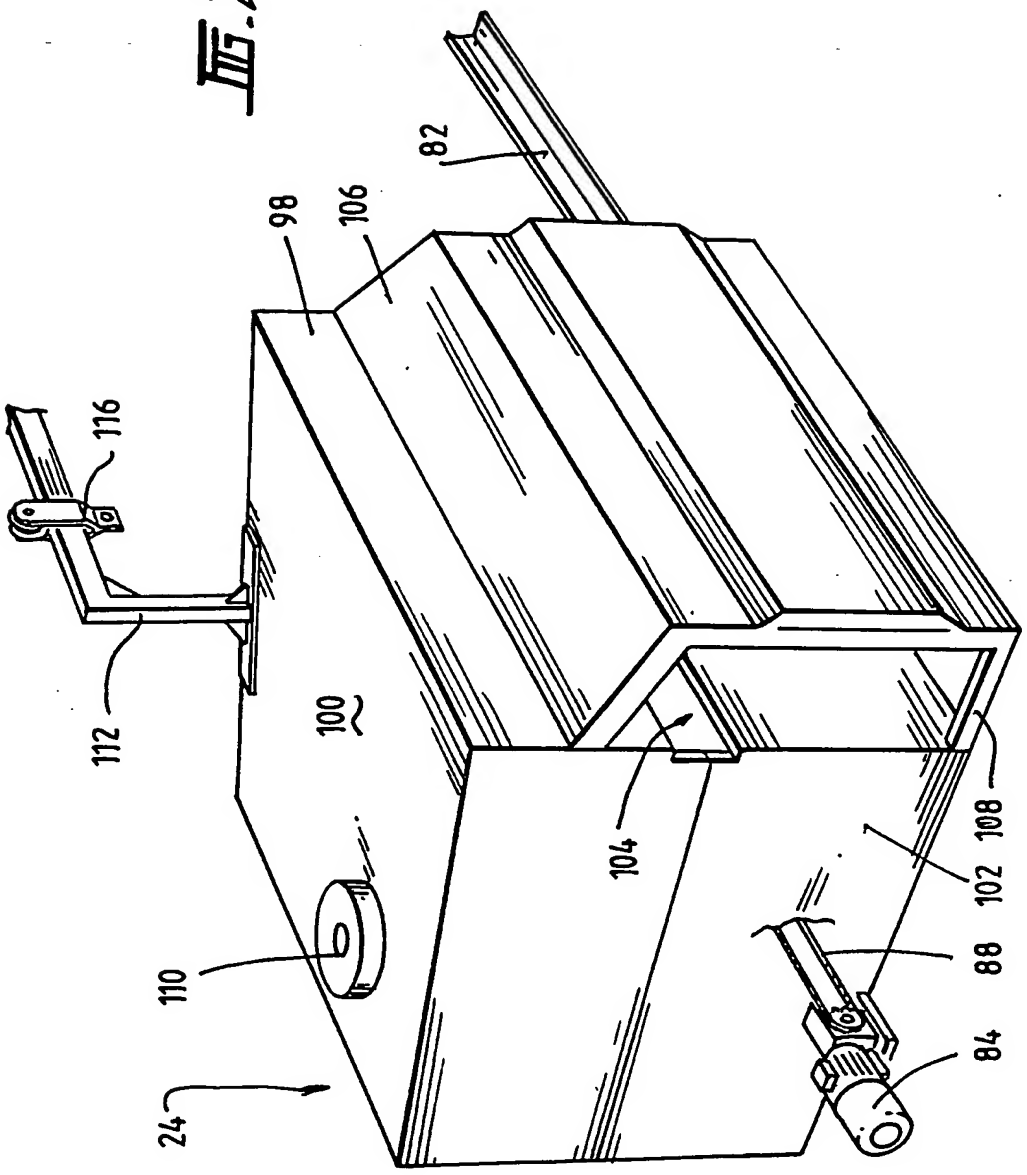
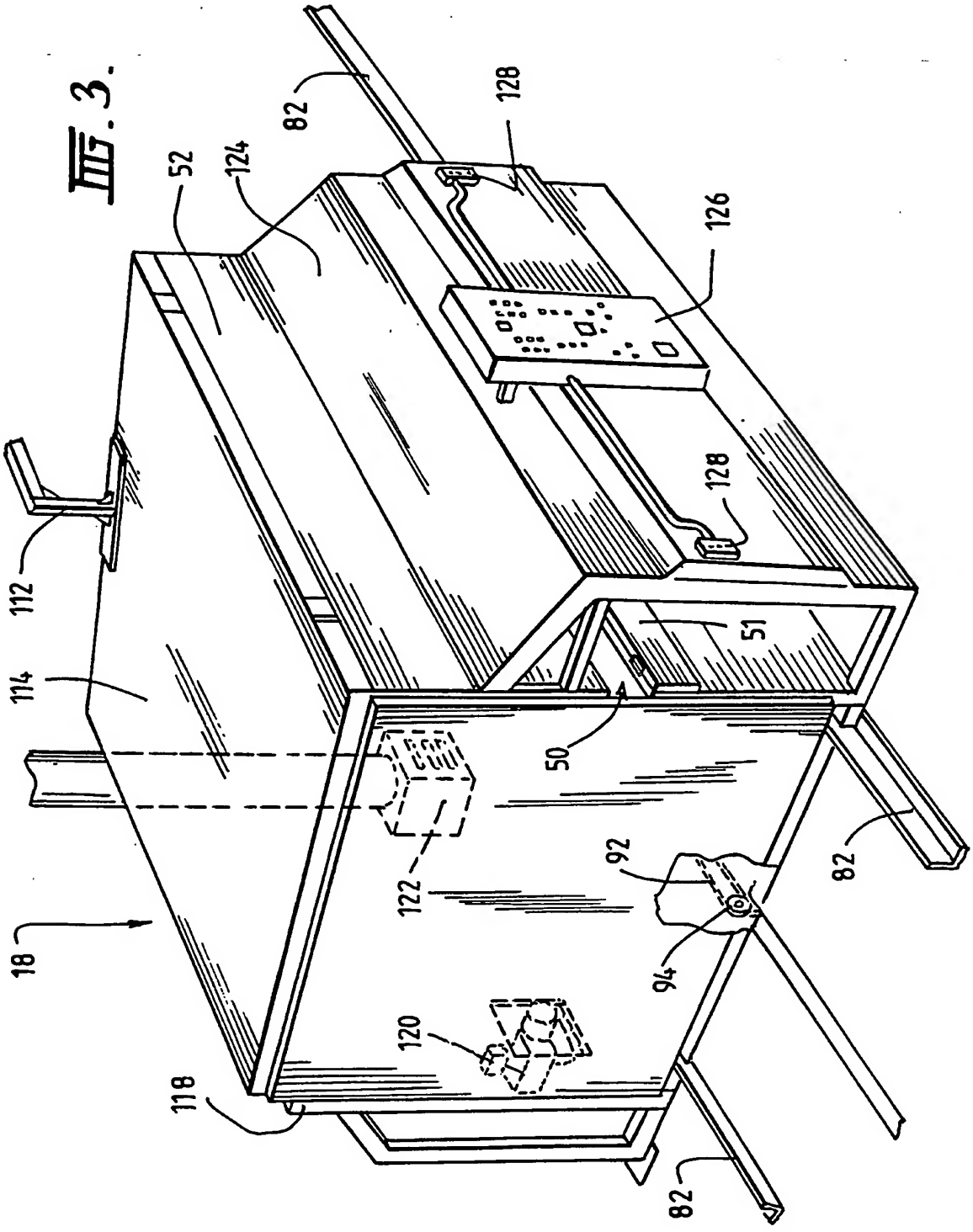


Fig. 3.



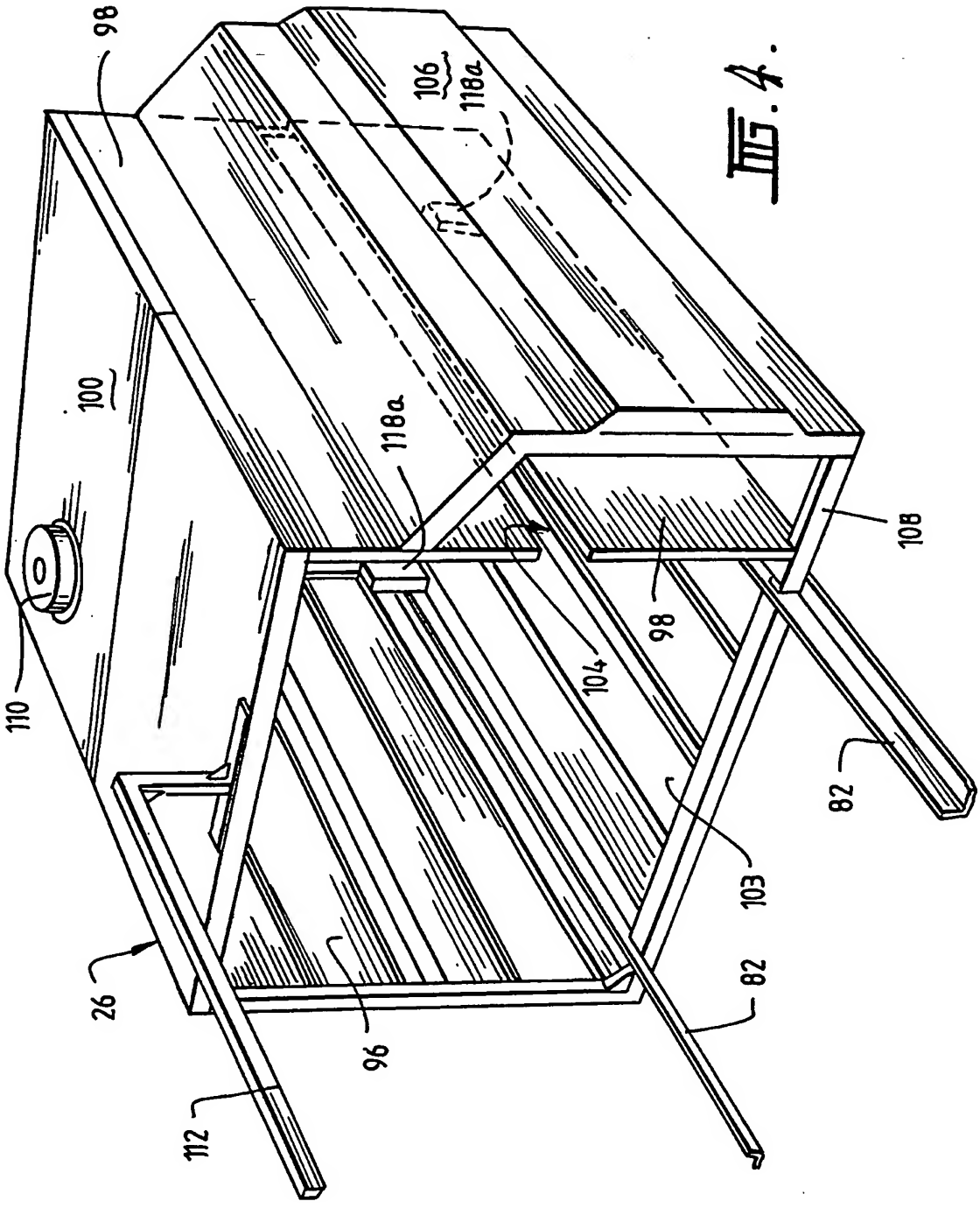


FIG. 4.

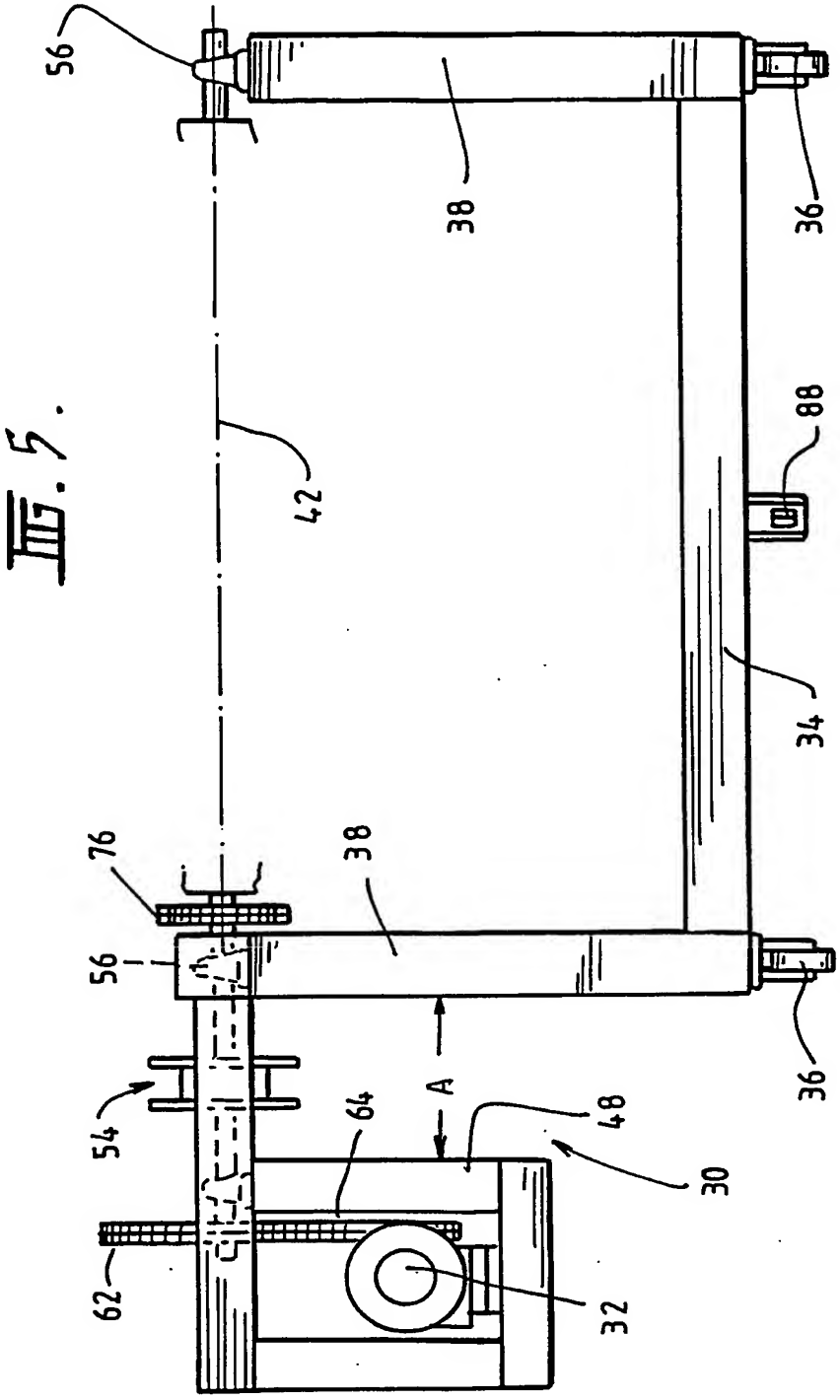
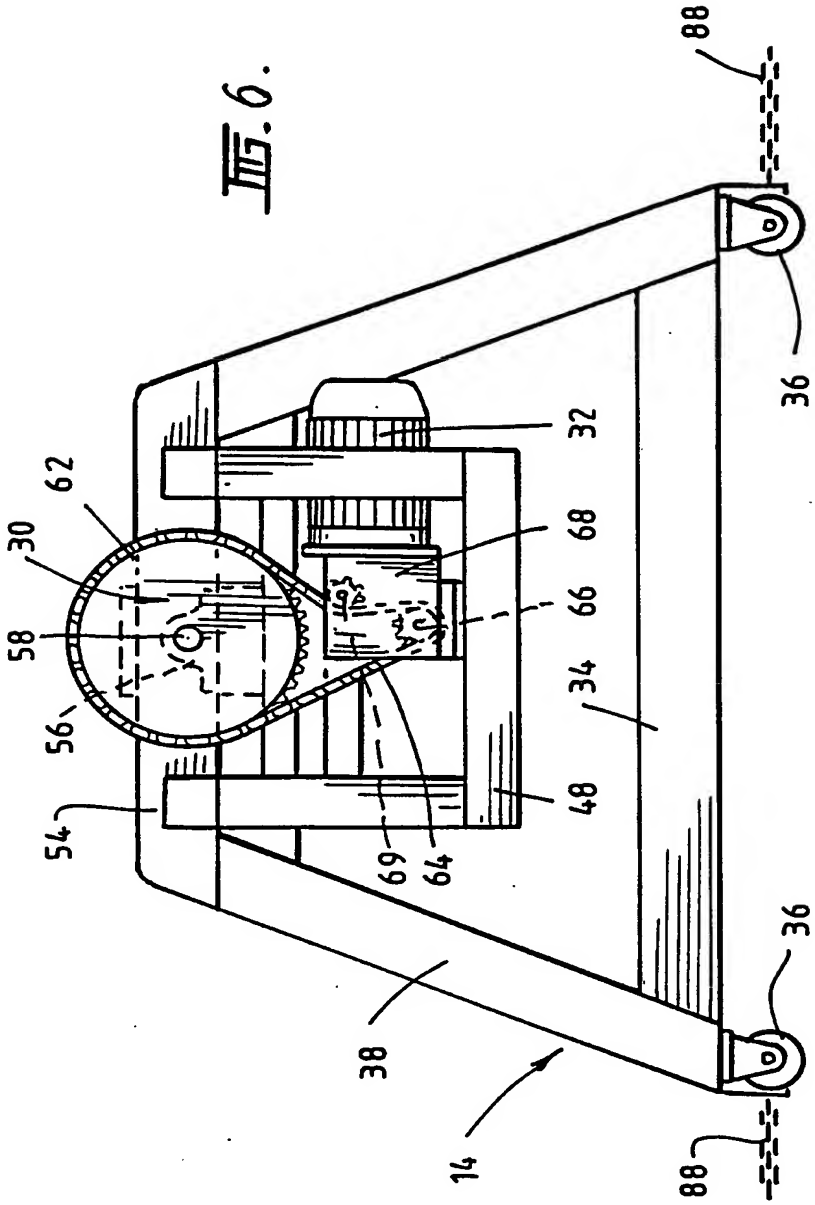


FIG. 5.

Fig. 6.



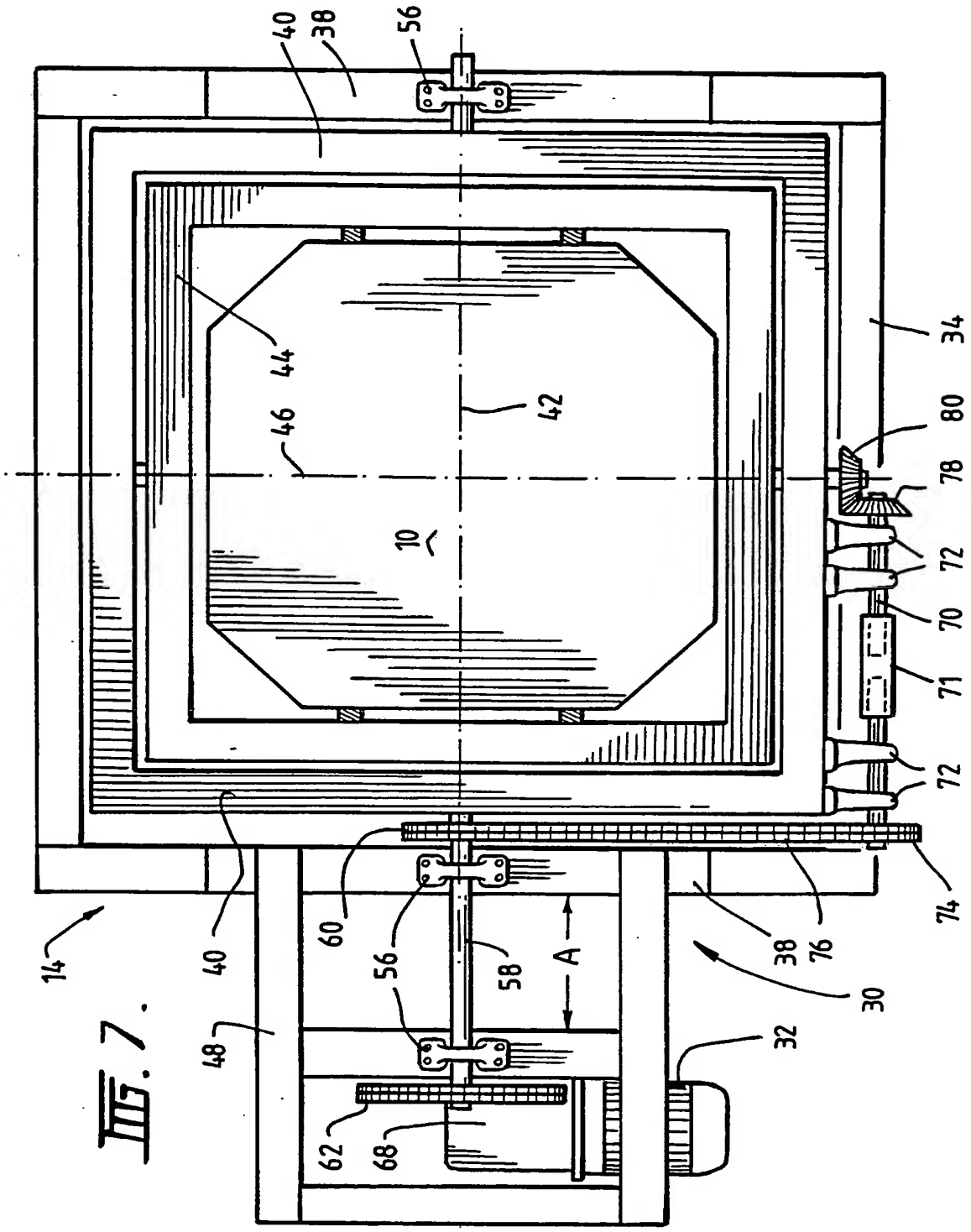

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FIG. 7.

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00327

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B29C 41/00, 41/06, 41/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: Int Cl as above and B29C 5/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU:IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT, JAPIO: B29C 5/04 and (Shuttl: or swap: or chang: or replac: or exchang: or cycl: or shuffl:)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4247279 A (MASTERS) 27 January 1981 Figures, claims	1 - 13
X	US 3413687 A (BAVERS) 3 December 1968 Figures, claims	1 - 12
X	US 3677670 A (MORI) 18 July 1972 Figures, Abstract, Claims	1 - 5, 8 - 12

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 July 1996	7 AUGUST 1996
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929	Authorized officer **ROGER HOWE** Telephone No.: (06) 283 2159

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00327

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3596324 A (BAVERS) 3 August 1971 Figures, claims	1 - 12
A	US 3829272 A (CARILLON) 13 August 1974 Abstract	1 - 13
A	US 4516924 A (RAWLINGS) 14 May 1985 Abstract	1 - 13
A	GB 1254090 A (MITSUBISHI PETROCHEMICAL CO. LTD.) 17 November 1971 Figures	1 - 13
A	FR 2595975 A (ANISA S.A.) 25 September 1987 Abstract	1 - 13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
PCT/AU 96/00327

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	3677670	DE	2022324	GB	1300167		
US	3596324	CA	917865				
US	3829272	CA	1052959	DE	2424430	JP	50019625
							END OF ANNEX